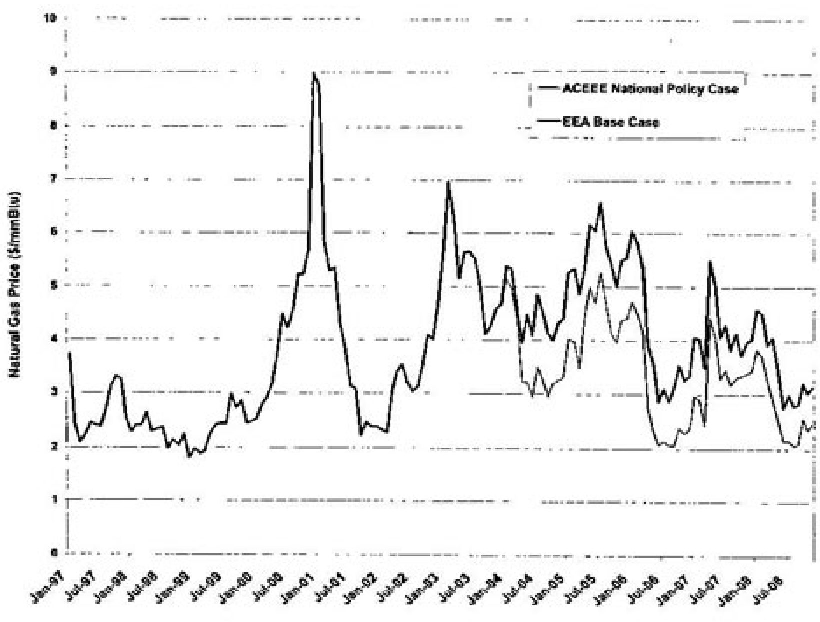
Executive Summary

This analysis, undertaken by the American Council for an Energy-Efficient Economy (ACEEE) (with the modeling assistance of Energy and Environmental Analysis (EEA)), shows that energy efficiency and renewable energy could cost-effectively reduce natural gas prices and volatility, while significantly reducing consumer natural gas expenditures. Much of the recent growth in natural gas use has been fueled by new natural gas-powered electricity generation, so it is important to understand the linkages between the natural gas and electric power sector. The analysis incorporated price, consumption and expenditure effects of aggressive, but readily achievable efficiency programs and renewable energy resources in the lower 48 states.

Summary of Findings

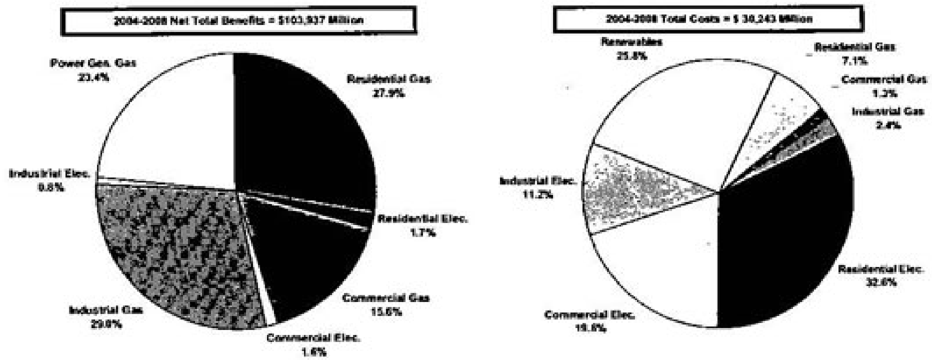
This analysis found that modestly reducing both natural gas and electricity consumption, and increasing the installation of renewable energy generation could dramatically affect natural gas price and availability. In just 12 months, nationwide efforts to expand energy efficiency and renewable energy could reduce wholesale natural gas prices by 20% (Figure ES- 1) and save consumers $15 billion/year in retail gas and electric power costs. Efforts to increase energy efficiency and renewable energy in just one state or region are also found to have significant effects on natural gas prices both regionally and nationally.

Figure ES- 1. Energy Efficiency and Renewable Energy Reduce Wholesale Gas Prices



Over the next five years, the cumulative net savings in natural gas expenditures to residential, commercial, and industrial consumers could exceed $75 billion (Figure ES- 2). In addition, electric power generators would reduce expenditures for natural gas by $24 billion. This reduction would result from the combined impacts of reduced natural gas prices, and reductions in natural gas consumption due to decreased consumer demand and expanded renewable electric power generation. In addition to the natural gas savings, electric consumers would see an additional net benefit of about $4.2 billion over the next 5 years. The net benefits from the efficiency and renewable energy measures over the next 5 years would total $104 billion.

Figure ES- 2. Net Benefits and Implementation Costs from Energy Efficiency and Renewable Energy



Achieving these benefits would require an investment of $30.2 billion over five years (Figure ES-2). This total includes required investment in natural gas and electric efficiency measures and in new renewable electric power generation, along with program costs required to facilitate the implementation of the measures. These measures result in a net benefit/cost ratio of about 3.44 to 1. Nearly two-thirds (64%) of the total expenditures are for electric efficiency measures, with renewable electric generation accounting for about a quarter of the investment. However, almost three-quarters of the benefits accrue to residential, commercial and industrial gas consumers. Thus, one can see that reductions in natural gas consumption by the electric power sector resulting from electric efficiency and expanded renewable power generation are critical to addressing natural gas price pressures. Table ES- 1 summarizes results on the costs and benefits associated with a nationwide efficiency and renewables effort.

Table ES- 1. Summary by Sector and Measure of Net Benefits and Implementation Costs from Energy Efficiency and Renewable Energy

	Natural Gas Expenditure Reduction (Million $)	Electricity Expenditure Reduction (Million $)	Technology Investment (Natural Gas) (Million $)	Technology Investment (Electricity) (Million $)	Program Costs (Million $)
Residential	28,964	1,764	1,684	7,913	561
Commercial	16,196	1,689	331	5,282	83
Industrial	30,151	788	603	2,727	158
Power Generation	24,361	N/A	N/A	N/A	N/A
Renewables	N/A	N/A	N/A	5,851	1,950
Total	**99,672**	**4,241**	**2,618**	**21,773**	**2,752**

What Will This Mean for Consumers?

Recent public concerns about natural gas supplies have been motivated by the price volatility in natural gas markets over the past three years. Consumers have seen prices spike to levels not observed in recent memory. The reasons for the price spikes are complex, though they can be characterized in general terms as a fundamental mismatch between gas supply and demand.

Many residential consumers have not become aware of the increases in natural gas prices that began last fall because customers are on fixed-cost annual contracts. Residential retail prices for 2003 are projected to be $2/thousand cubic feet (Mcf) higher than for 2002, with the higher prices projected to persist for at least the next four years. These residential consumers will begin to experience the price increases this fall with a national average increase of 36% in natural gas bills. If we have another cold winter, the cost could be difficult for many modest-income consumers to handle. However, energy efficiency investments could reduce next year's bills by 9%, saving the average residential natural gas consumer almost $73. These savings would continue, with savings for the next five years averaging $96/year.

Analysis Approach

The savings are the result of reductions in natural gas consumption brought about by changes in state and federal energy policies designed to increase the efficiency of natural gas and electricity consumption, and expansion of renewable power generation. The analysis predicts that in just 12 months efficiency measures could reduce national gas consumption by 1.9% from the base case and reduce electricity consumption by 2.2%. By 2008, we project the U.S. could reduce electricity consumption by 3.2% and natural gas consumption by 4.1%, and increase renewable generation from 2.3 to 6.3% of national generation. These changes would reduce wholesale gas prices by 22%.

The analysis also shows that reducing energy consumption and increasing renewable energy generation in just one state or region could result in dramatic wholesale natural gas price reductions on the order of 5 to 7% in the region. Energy efficiency and renewable energy can be deployed quickly with minimal siting or environmental roadblocks. While energy efficiency and renewable energy cannot address all our nation's future natural gas needs, they are the fastest and surest way to address high natural gas prices. Moreover, energy efficiency and renewable energy are low-cost answers that would be an important part of a solution to rising natural gas and electricity prices.

Electric Efficiency Is Part of the Natural Gas Solution

Electric efficiency will also help the looming natural gas problems that are projected to send consumer gas bills soaring this coming winter. Saving peak electricity is one of the fastest ways to reduce natural gas consumption. Our analysis found that because gas is disproportionately used for peak electricity generation, reducing electricity used for cooling and heating, lighting, and industrial processes could have a significant impact on gas usage and price. In addition, reducing electricity consumption could help relieve overloading the grid, which contributed in part to the blackout that occurred in the Midwest and Northeast on August 14, 2003. Investing now in energy efficiency and conservation would reap huge benefits for American consumers and for the fragile economic recovery. By shaving peak demands for electricity and natural gas, we could reduce prices, make energy bills manageable, avoid costly disruptions to business and to our daily lives, and put the American economy more firmly on the road to recovery.

Renewable Generation Helps Take Pressure Off Natural Gas Markets

Renewable energy resources take pressure off gas-fired electric generation in much the same way as electricity conservation. Electricity generated by wind, solar, and farm-based biomass disproportionately displace electric power production from gas-fired generators, thereby reducing gas demand and making it available at lower prices for other uses. Our analysis showed that modestly increasing renewables over the next five years would significantly reduce natural gas prices nationally. The same is true for renewable energy policy initiatives in states or regions. For example, in New York State we would be able to reduce wholesale natural gas prices in New York City by almost 2% in 2008.

Policy Recommendations

Policymakers at the state and federal level could take a number of concrete actions to realize the benefits that would likely result from expanded energy efficiency and renewable energy resources. No single policy strategy will achieve the results outlined here. Rather, a portfolio of strategies is most likely to achieve quick and sustained savings from energy efficiency and renewable energy resources. These strategies include:

- Energy efficiency performance targets supported by utility fees or system benefits charges
- Expanded federal funding for energy efficiency and renewable energy implementation programs at DOE and EPA including *Energy Star®*
- Appliance efficiency standards at both the federal and state level
- Insuring more efficient buildings through codes
- Support of clean and efficient distributed generation technologies
- Renewable portfolio standards
- Public awareness campaigns by state and national leaders with support for implementation programs

Public and private leaders need to step up to the podium and issue a call to action to implement the policies and programs needed to realize the benefits that will result from increased use of energy efficiency and renewable energy. A window of opportunity may be closing in the near future, so leaders must act now if the full, cost-effective benefits of energy efficiency and renewable energy are to be realized. We have provided some concrete policy recommendations. These policies are relatively low-cost and the measures recommended are cost-effective from the customer's perspective. However, local, state, and federal government must all be prepared to commit resources if this opportunity is to be realized.

Introduction

In this report, ACEEE, with the assistance of Energy and Environmental Analysis, Inc. (EEA), explores the impact of energy efficiency and renewable energy on reducing natural gas prices and volatility. ACEEE developed estimates of reasonably achievable natural gas savings in the 48 continuous United States in the short term. These estimates were entered into a model of natural gas markets developed by EEA (2003). This model projects both regional and national price effects of changes in natural gas consumption from a baseline. The model shows that increased energy efficiency and renewable energy use would significantly reduce natural gas prices for all consumers and put downward pressure on electricity prices.

Small changes in natural gas consumption can have disproportionately large impacts on natural gas prices because they reduce prices at the margin where they are highest. In some regions of the country, demand exceeds the ability of the natural gas infrastructure to deliver gas for brief periods of the year, creating even greater price pressures that modest savings could relieve. Furthermore, reductions in gas prices can have large impacts on natural gas-dependent industries such as fertilizer manufacturing. Reduction in natural gas prices can help these industries and their customers remain in business.

Overview of Analysis

Based on a review of existing literature, ACEEE developed estimates for the 48 contiguous states of the near-term (i.e., 1-year) and mid-term (i.e., 5-year) implementable potential for:

- Energy efficiency and conservation programs targeted at natural gas
- Energy efficiency and conservation programs targeted at electricity

These estimates have been made at the sectorial level for residential, commercial, and industrial consumption and are discussed in more detail in the Methodology section of this report.

Similarly, ACEEE developed implementable potential estimates for renewable resources for the 13 National Electric Reliability Councils (NERC) sub-regions based on a survey of existing research results and interviews with experts.

These ACEEE estimates served as an input matrix to the EEA natural gas model. It evaluates natural gas supply and demand at the national level, producing price projections at 106 points across North America. The model includes an electricity generation module, so reductions in electricity demand can be explored. The model also produced a baseline assessment.

The model was used to analyze four policy scenarios:

	Measures Analyzed		
Scenarios	Electric Efficiency	Natural Gas Efficiency	Renewable Resources
National (lower 48)	X	X	X
Pacific West*	X	X	X
Northeast/PJM**	X	X	X
New York State Renewables			X

Notes: *California, Oregon and Washington
** ME, MA, VE, NH, CT, RI, NY, NJ, PA, DE, and MD

In each state or regional scenario, the measures were applied in only the listed states. The model then produced a national projection with estimates of local price impacts at all locations reported. This approach identified the relative impacts of programs in several key gas-consuming regions.

Description of EEA Model

EEA's *Gas Market Data and Forecasting System* is a full supply/demand equilibrium model of the North American gas market. The model solves for monthly natural gas prices throughout North America, given different supply/demand conditions, the assumptions for which are specified by the user. Overall, the model solves for monthly market clearing prices by considering the interaction between supply and demand curves at each of the model's nodes. On the supply-side of the equation, prices are determined by production and storage price curves that reflect prices as a function of production and storage utilization. Prices are also influenced by "pipeline discount" curves, which reflect the change in the basis or the marginal value of gas transmission as a function of load factor. On the demand-side of the equation, prices are represented by a curve that captures the fuel-switching behavior of end-users at different price levels. The model balances supply and demand at all nodes in the model at the market-clearing prices determined by the shape of the supply and curves. Unlike other commercially available models for the gas industry, EEA does significant back-casting (calibration) of the model's curves and relationships on a monthly basis to make sure that the model reliably reflects historical gas market behavior, instilling confidence in the projected results (EEA 2003).

Energy Expenditure Savings and Benefit/Cost Analysis

The output from the EEA model provided changes in natural gas consumption and prices at the state level by sector. These results allowed the calculation of changes in consumer natural gas expenditures. ACEEE then projected the changes in electric expenditures based upon the electric efficiency inputs and projected base-case electric prices by sector and state. Combined, these two analyses produced cumulative savings over the five-year-model period of $103.9 billion.

Based on a review of past program results, ACEEE developed estimates of the investment required to achieve the reductions in natural gas and electricity developed in the input data set, as is discussed in detail in the Investment and Program Cost section. These estimates include projected cost to administer the program on a state-by-state basis. An estimate was also made of the investment required to deploy the addition renewable resources projected, again including administrative costs. Based on this analysis, ACEEE estimates a total cost to achieve the results modeled in this analysis of $24.4 billion over five years.

Based on these analyses, ACEEE projects a national average benefits/costs ratio of 3.44 for the national energy efficiency and renewable energy scenario modeled in this study.

History and Background

Recently, natural gas has begun to receive attention in ways that have not been seen since the 1970s. Over the past few years the price of natural gas has risen, but more importantly, has become highly volatile. The reasons for this natural gas price-response are complex, but have drawn the attention of decision makers not normally associated with energy policy. As Federal Reserve Chairman Allen Greenspan (2003) recently testified:

> *In the United States, rising demand for natural gas, especially as a clean-burning source of electric power, is pressing against a supply essentially restricted to North American production. ...Futures markets project further price increases through the summer cooling season to the peak of the heating season next January. Indeed, market expectations reflected in option prices imply a 25 percent probability that the peak price will exceed $7.50 per million Btu. ...Today's tight natural gas markets have been a long time in coming, and futures prices suggest that we are not apt to return to earlier periods of relative abundance and low prices anytime soon.*

Chairman Greenspan's testimony served as a wakeup call to the Washington policy community. Energy efficiency, conservation, and renewables are now widely being acknowledged as the sole near-term policy options. This is demonstrated by Secretary Abraham's letter to state utility commissions (Abraham 2003), the National Petroleum Council's *Balancing Natural Gas Policy* report (NPC 2003) and the findings of the Speaker's Task Force for Affordable Natural Gas (House 2003). While the role of efficiency, conservation, and renewables is now receiving greater attention, it remains to be seen how effective the policymakers' actual responses will be.

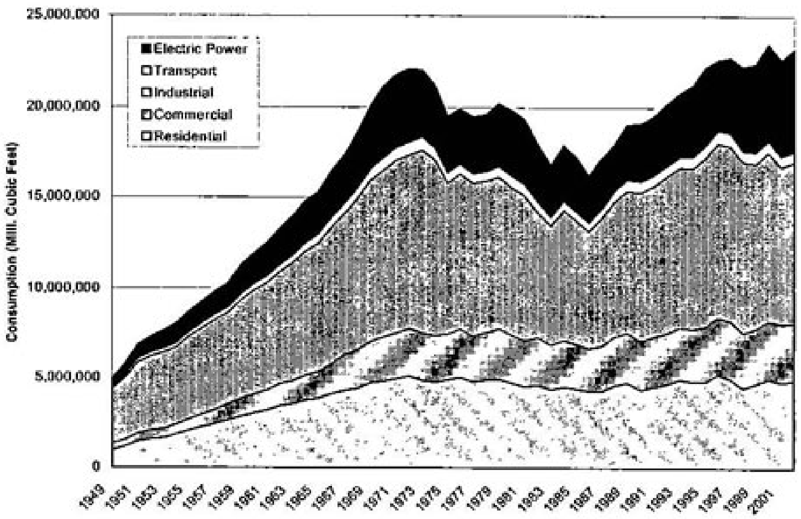
Current Natural Gas Pricing and Availability Environment

Much of the recent concern about natural gas supplies has been motivated by recent price uncertainties. Over the past three years, we have seen prices spike to levels not seen in recent memory. The reasons for the price spikes are complex, though they can be characterized in general terms as a fundamental mismatch between gas supply and demand.

Consumption

Since World War II, natural gas has played an increasingly important role in the U.S. energy picture. All energy-using sectors expanded their use of gas, with the industrial and residential sectors leading the growth (see Figure 1). Total gas usage peaked in the early 1970s at roughly four times the 1950 level. With the price increases and energy crises of the 1970s, industrial and utility gas consumption declined until 1987 when falling gas prices spurred another rise in consumption. Thereafter, all consuming sectors experienced an increase but the most dramatic increases occurred in the industrial and power-generation sectors that had been discouraged from using gas during much of the late 1970s and early 1980s because of regulation and price.

Figure 1. Natural Gas Consumption by End-Use Sectors (Source: EIA/AER 2003)



Price Trends

Real (i.e., inflation-adjusted) natural gas prices were steady through much of the 1960s, but began increasing with the energy crisis in 1973 (see Figure 2). Average natural gas prices peaked in 1983, and began to fall to an inflation-adjusted low in 1995. Prices then again began to increase around 1999.

Historically, natural gas prices fluctuate seasonally. The prices in all sectors except residential have fluctuated with demand: the highest prices correspond to the months of highest consumption during the winter (see Figure 3). The very cold winter of 1996-97 resulted in a significant consumption-induced price spike also seen in Figure 3. Average residential prices, however, are counter-cyclic, driven by fixed service charges with the highest prices corresponding to periods of lowest consumption during the summer.

Following the price spike in January of 1997, wellhead, industrial, and utility prices quickly fell to low levels. This price pattern was disrupted beginning in the spring of 2000 as prices began to rise and continued to rise to near record levels the following January. Prices then rapidly fell back to more normal levels in the summer of 2001. However, the unusually warm winter of 2001-02 saw winter prices fall to low levels in February of 2002. Prices then began a climb that has, for the most part, continued until recently (see Figure 3). Retail prices did begin to moderate in the summer of '03 but have increased with the fall as heating demand increases (EAI/SEO 2003).

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Figure 2. National Average Annual Real Prices of Natural Gas by End-Use Sectors (Source: EIA/AER 2003)

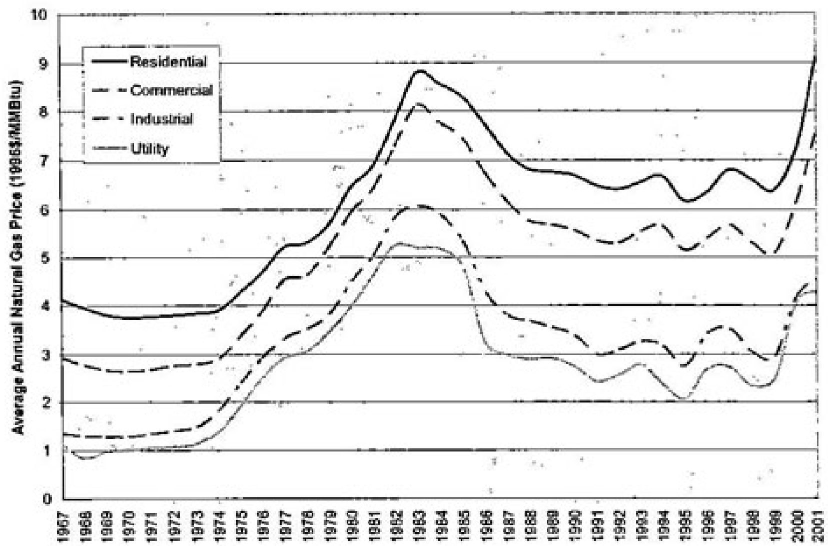
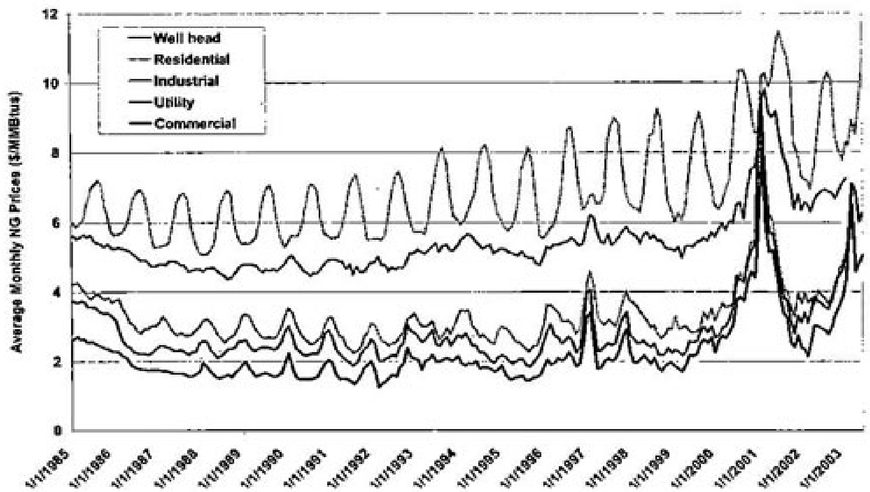


Figure 3. National Average Nominal Monthly Prices of Natural Gas by End-Use Sectors and at the Wellhead (Source: EIA/MER 2003)



Reasons for Current Market Instability

While market manipulation by natural gas marketers (such as the now infamous Enron) have been blamed for the price spikes in 2000 and 2001, similar attribution is much more difficult for the current run-up in prices. It appears that an imbalance between supply and demand contributed to both price spikes. Many experts feel that as the existing low-cost natural gas fields were depleted by the increases in consumption, and that low wellhead prices during most of the 1990s discouraged expanded exploration for new gas supplies that have a higher development costs (Chicago Fed 2003). As can be seen from Figure 4, natural gas exploration (as measured by rigs looking for gas) have increased in response to rising wellhead prices, only to fall back when prices drop below the point of financial attractiveness. While existing drill rigs are now fully deployed, with 93% looking for gas (EIA/NGM 2003), anecdotal reports say that little interest has been shown by the industry to market capital investments in new exploration capacity until evidence emerges that gas prices are likely to remain high for the longer term. Some experts speculate that if prices remain above $4 per million Btu, significant new gas production would emerge (Henning 2003).

In the short term, it appears that natural gas supplies will remain tight, and prices are likely to remain high for the next 2 to 3 years. This amount of time is needed for the supply markets to respond to the price signal. Longer term, many experts project that prices are likely to fall from the current level to something in the $4–5 dollar range per million Btu, but few are forecasting a return to the $2 per million Btu wellhead prices of the 1990s (EIA/SEO 2003; EEA 2003; Weismann 2003).

Growing Importance of Natural Gas in Electricity

One of the contributing factors to recent increases in natural gas consumption has been an expansion of natural gas-fueled electricity generation. Over the past 15 years, natural gas has assumed an increasing significant role in domestic electricity markets, now accounting for almost 20% of annual generation (EIA/MER 2003). The major motivations for this expansion of capacity was the relatively low cost of new gas generation plants, combined with bountiful, low-cost supplies of gas and the emergence of deregulated wholesale markets.

Figure 4. Comparison of Wellhead Price of Gas to Drill Rigs Looking for Gas (Sources: Baker Hughes 2003; EIA/NGM 2003)

Natural gas or dual fuel[1]-capable generation has increased from 30 to 41% of installed fossil generation, and from 22 to 30% of total generation in the past decade. The most dramatic increases in capacity occurred in 2000 and 2001, for the most part with exclusively gas-fired units (EIA/EA 2002). Other sources indicate that this trend of expanded gas capacity extended into 2002, despite slower growth in new gas fired capacity.

Combined heat and power (CHP) represents an important element of the generation base. Much of the CHP capacity installed in the past decade is gas-fired (EEA 2003). EIA groups this natural generation into categories (see Figure 5): commercial CHP, industrial CHP, and power-only generation. Since 1993, the CHP share of total natural gas generation has grown by 17%, while the electric-only gas generation has expanded by 75% (EIA/MER 2003).

In most regions, natural gas represents a disproportionate share of peak electricity generation (see Figure 6) (Barbose 2003). Electric efficiency and renewable generation investments have the largest impact on gas prices in regions with high gas-fired electric peak generation.

[1] EIA characterizes a duel fuel as capable of operating on natural gas or petroleum, although in reality most capacity has recently been operating on gas.

Figure 5. Natural Gas-Fired Electricity Generation by Facility Class (Source: EIA/MER 2003)

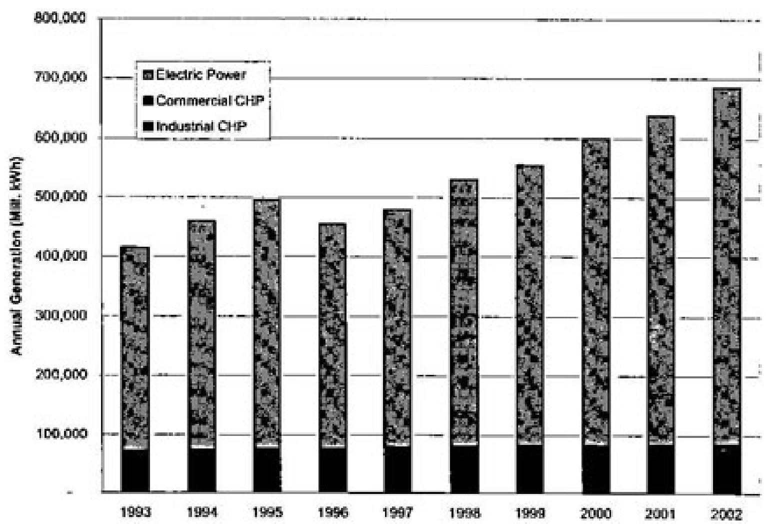


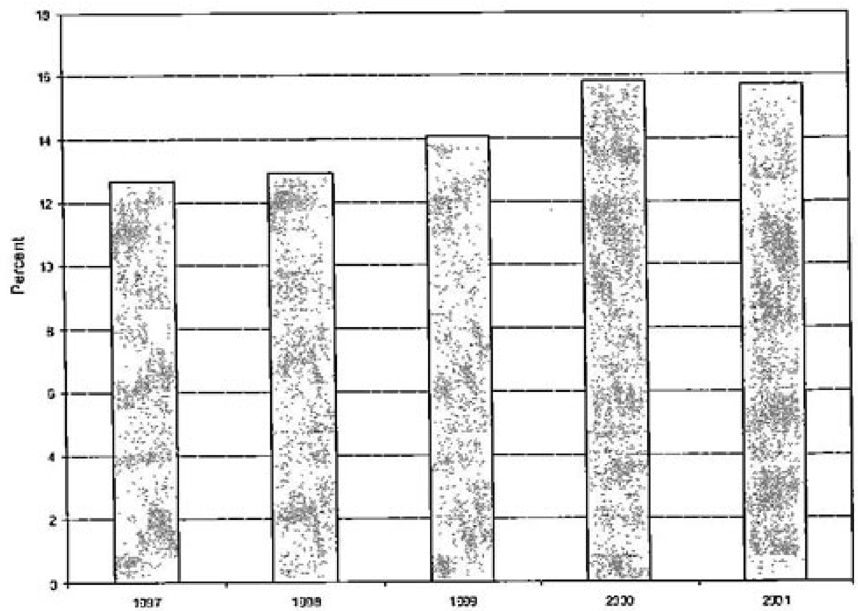
Figure 6. Percentage of Utility- and IPP-Installed Capacity Composed of Non-Combined Cycle, Natural Gas-Fired Plants (Source: Barbose 2003)

Natural Gas Reserves

While much of the current debate about gas prices implies that we are running out of gas, EIA estimates U.S. technically recoverable reserves to be over 1,430 trillion cubic feet (EIA/OGR 2003). These reserves should be sufficient to meet domestic consumption at the current level for 60 years. In addition, imports have been increasing, both from Canada and from liquid natural gas imports from overseas (see Figure 7).

While natural gas reserves are large and the potential for increased imports are significant, it is clear that the costs of bringing natural gas to the markets are increasing (Henning 2003). In summary, while we are in no imminent risk of running out of natural gas, the question is at what cost will the gas be available? Many analysts believe the U.S. economy will need to bear an increasing cost as the market prices of gas increase.

Figure 7. Net Imports as a Percentage of Total Consumption of Natural Gas, 1997–2001 (Source: EIA/NGM 2003)



Market Impacts of Rising Natural Gas Prices

Industrial and electric power consumers have been reeling under recent price increases. The industrial sector has been hard hit. This sector's consumption fall 16 percent from the highs of the late 90s due to the combined impacts of the economic downturn and rising natural gas prices. Some gas dependent industries such as organic chemicals and nitrogenous fertilizer are reducing production or closing domestic production and moving overseas.

The fertilizer industry has been particularly hard hit with an overall 45% reduction in production and the permanent closure of eleven ammonia plants representing 21% of U.S, capacity in the past three years (House 2003 and GAO 2003). Further closures are anticipated unless prices moderate. These impacts are felt not just at the industrial facilities, but also impact users of these factories' products. Farmers have experienced a 100% increase in fertilizer prices in the past year amounting to a 4% increase in their cost of production. The Speaker's Task Force for Affordable Natural Gas (House 2003) indicates that this situation is "shrinking profit margins for agricultural products, increasing the cost of food on the table and putting additional pressure on the already endangered family farm, farm states, and the agricultural sector of the economy."

As noted earlier, over 90% of new power generation in this country is fueled with natural gas. The increases in natural gas prices to electric power generators are raising the cost of electric power while imperiling the financial solvency of some new power plant owners. Already some new plants have been delayed or canceled, raising question of where the power will come from to satisfy growing demand for electricity (House 2003 and Weismann 2003).

Because of the pricing structure of many residential gas supply contracts and their low summer demand, many have yet to experience the full brunt of the dramatic price increases that other sectors of the economy have already experienced. Residential consumers will begin to experience the price increases this fall as consumer demand increases and their local distribution companies (LDC) begin to pass along the commodity increases as price increases in order to recover the costs they incurred in the winter from the higher gas prices. Thus, residential natural gas bills are likely to rise dramatically as we move into the fall heating season (EIA/SEO 2003).

Methodology

Because of the design of the EEA natural gas model, ACEEE needed to estimate the energy consumption reductions that could be implemented through energy efficiency and conservation on a state-by-state basis for the three primary end-use consuming sections: residential, commercial, and industrial. In addition, we needed to estimate implementable additions to renewable generation stocks above the base case at the regional level.

Different approaches were used for estimating the implementable potential for energy efficiency and renewables energy. Energy efficiency and conservation were assumed to impact consumption of natural gas and electricity, while new renewable energy resources were added to the regional electric power generation base. For energy efficiency and conservation, savings potentials were estimated for each of the lower 48 states for both direct use of natural gas and for use of electricity in the primary end-use sectors. Savings from energy efficiency and conservation were assumed to be front loaded, while the estimates for net new renewables were assumed to be added equally in the second through fifth year of the analysis.

General Approach for Energy Efficiency and Conservation

Similar, bottoms-up approaches were used for all end-use sectors for the energy efficiency and conservation analyses for both electricity and natural gas. Estimates of the major natural gas and electricity end uses for each of the states were developed. Based on a review of available literature, estimates were developed of the implementable savings that could be achieved in five years through the implementation of aggressive programs similar to those that have been deployed in recent years in response to recent regional energy shortages. These estimates were then applied to the end-use estimates in each state to develop sectoral estimates of energy savings for each state.

General Assumptions

To facilitate the performance of this analysis, we made several assumptions. The following parameters are assumed to be embodied in the base-case analysis, and were not being considered in the scenarios (except as noted):

- Demand destruction—the permanent elimination of energy demand due to facilities closing or shifting operations to other regions.
- Price-based fuel switching outside of renewables;
- Utility plant shutdowns or ramp-ups.
- Changes to natural gas infrastructure (except in the NYS/RPS scenario where we will explicitly assume no new gas transmission lines are constructed during the study period).
- A change in industrial feedstock utilization or sourcing—natural gas is used by some industries as a feed stock in addition to its use as a fuel.

To make the analysis doable, we made the following simplifying assumptions:

- Potential for industrial end-use energy efficiency and conservation does not vary by region.
- The load curve for industrial power and natural gas consumption does not vary seasonally.
- No significant new renewable resources are likely to become available in the first year above the base case.
- Wind, biomass, and solar are the principal renewable resources contributing to displaced utility generation above the base case.
- Additional displacement of consumer end-use gas by renewables is considered small, and is assumed to be zero for purposes of this analysis.

State-by-State Adjustments

The potential to achieve energy-efficiency savings varies among the states. Some states like New York and California have well established energy-efficiency programs supported by many market allies, and could expand efficiency programs off of existing policy platforms. Some other states, such as South Dakota and Mississippi, have no record of running energy efficiency programs, so are less likely to be able to rapidly deploy new programs. In order to estimate the energy saving potential for individual state, a state a weighting factor was developed. This state-weighting factor is intended to measure the current status of a state's energy-efficiency and renewable energy delivery infrastructure. The quality of the infrastructure is based on a matrix of policy handles and mechanisms, intended as a quantifiable measure of the various qualitative policy mechanisms (Table 1). Based on these factors, a "grade" was assigned to each state. Grades of "a", "b", "c", and "d" were assigned to each state. An "a" represented 100%, a "b" was equal to 85%, a "c" was equal to 70%, and a "d" was equal to 55%. This means that an "a" state would be able to achieve 100% of the regional savings potential. California, for example, located in the west census region was given a grade of "a" for its energy-efficiency and renewables infrastructure. The west regional maximum achievable five-year electricity and natural gas savings are 5.41% and 5.19%, respectively. California is expected to be able to achieve 100% of these savings under an aggressive policy scenario.

Table 1. State Energy Efficiency and Renewable Energy Programs and Policies

State	Public Benefit Fund[2]	IAC	RPS	Residential Buildings Codes	Commercial Buildings Codes	Utility Restructuring[3]	Regional Initiatives	Environmental Trust/ Environmental Trading Group	Tax Credits for Energy Efficiency	Tax Credits for Renewables	Score
Alabama	0	y		c	c	N					d
Arizona	0	y		c	c	A			Y	Y	b
Arkansas	0			c	b	D					d
California	2	y	y	a	a	S		Y			a
Colorado	1	y		c	c	N					b
Connecticut	2	y	y	b	b	A	y				a
Delaware	1	y		c	b	A	y				b
Florida	1	y		a	a	N					c
Georgia	0	y		a	a	N					d
Idaho	1			a	a	N			Y	Y	b
Illinois	0	y		c	c	A	y				b
Indiana	0	y		c	c	N	y				c
Iowa	1	y		c	b	N	y				b
Kansas	0			c	b	N					d
Kentucky	0			a	a	N					d
Louisiana	0	y		c	b	N					d
Maine	2		y	c	a	A	y				a
Maryland	0	y		a	b	A	y		Y	Y	b
Massachusetts	2		y	b	a	A	y	Y	Y	Y	a
Michigan	0	y		c	c	A	y				b
Minnesota	1			b	b	N	y				b
Missouri	0			c	c	N	y				d
Mississippi	0			c	c	N					d
Montana	1			c	b	D	y				c
Nebraska	0			c	c	N					d
Nevada	0		y	c	c	D					c

[2] Spending greater than 1% of revenues = 2, greater than 0.1% =1, and less than 0.1% = 0
[3] N=no, A=active, D=delayed, S=suspended (CA only)

State	Public Benefit Fund[2]	IAC	RPS	Residential Buildings Codes	Commercial Buildings Codes	Utility Restructuring[3]	Regional Initiatives	Environmental Trust/ Environmental Trading Group	Tax Credits for Energy Efficiency	Tax Credits for Renewables	Score
New Hampshire	1	y		a	b	A	y				b
New Jersey	2	y	y	b	a	A	y		Y	Y	a
New Mexico	0			a	a	D					d
New York	2	y		a	a	A	y		Y	Y	a
North Carolina	0	y		a	a	N					d
North Dakota	1			a	c	N					d
Ohio	0	y		a	a	A	y				c
Oklahoma	0	y		b	b	D					d
Oregon	1	y		a	a	A	y	Y	Y	Y	a
Pennsylvania	1	y	Y	a	a	A					a
Rhode Island	2	y		a	a	A	y				a
South Carolina	1			a	b	N					d
South Dakota	0			c	c	N					d
Tennessee	1			c	c	N					c
Texas	1	y	y	a	a	A					a
Utah	1	y		a	a	N					b
Vermont	2	y		b	c	N	y				a
Virginia	0	y		b	b	A					c
Washington	1	y		a	a	N	y				b
West Virginia	0	y		c	c	N					d
Wisconsin	2	y	y	a	b	N	y				a
Wyoming	1			c	c	N	y				c

Residential/Commercial Methodology and Characterization

General Approach

The estimation of the implementable savings from the residential and commercial sectors used a "bottoms-up" approach. The analysis began with data on energy use in each of the 48 states by end-use (e.g. lighting, cooling, heating, etc). A variety of published studies were then used to estimate average annual electric and gas savings over five years from efficiency programs, including adjustments for reasonable savings by end-use. We then estimated the savings achievable in one year, relative to savings achievable over five years. Finally, we looked at current policy initiatives to promote efficiency in each of the 48 states, and adjusted savings downward in states without strong efficiency policies, reasoning that a sudden change in policy was unlikely, thus, lower savings were likely in these states. Each step is discussed in the following sections.

Base Case by End-Use

Base case energy use for each state was estimated for each of the 48 states using data from the *1997 Residential Energy Consumption Survey* (RECS) (EIA 1999) and the *1999 Commercial Building Energy Consumption Survey* (CBECS) (EIA 2001a).

RECS provides energy use consumption and saturation figures for the four largest states (California, Texas, New York, and Florida) and for each Census region. We used data for space heating, space cooling, water heating and appliances/other. For the 44 states not individually profiled, we assumed that the regional figures would apply. For Census regions with the four large states, we subtracted out data on the large state in order to calculate average energy use for the remaining states. In the case of the Mountain region, given the large differences in latitude involved, we differentiated between north Mountain and south Mountain using data from a study on the region by the Southwest Energy Efficiency Project (SWEEP 2002).

CBECS also provides data on each region, but not for individual states. End-uses covered were space heating, space cooling, water heating, lighting, refrigeration, ventilation, cooking, office equipment, and other. We used regional data to characterize each of the individual states.

Overall Energy Savings Achievable Over Five Years

A variety of studies have been conducted in recent years to estimate the economic and achievable efficiency potentials for reducing gas and electricity use in different states. Economic potential is an estimate of the savings that can be achieved if all measures which are cost-effective to end-users are implemented. Achievable potential is a subset of economic potential and includes allowances for reasonable measure penetration rates given likely policy and program interventions.

To estimate achievable potential over one and five years, we considered two types of data. First, substantial savings can be achieved in the short-term through behavioral changes in response to high prices and appeals for conservation. For example, in 2001, in response to the California electricity crisis, California end-users reduced their energy use about 6%, of which about two-thirds was a behavioral response (Global Energy Partners 2003). Thus Californians used behavioral actions to reduce energy use by about 4%. The California situation was particularly dire; therefore, we estimated that a new campaign in response to the natural gas crisis could only achieve two-thirds of these savings—an average of 2.7%.

Second, energy use can be reduced through hardware improvements. To estimate these savings, we compiled information from ten different studies, including six studies on potential gas savings and eight studies on potential electricity savings (four studies included both fuels). Energy savings estimates were divided by the period of analysis (e.g. five years, 20 years, etc.) in order to estimate annual incremental savings. We examined overall savings estimates by sector (residential and commercial), as well as by end-use. In estimating the overall savings achievable, we only looked at achievable potential studies, and in order to be conservative, emphasized the lower end of the savings estimates. Based on these studies, we estimated an overall achievable savings potential, from hardware improvements (Table 2).

Table 2. Achievable Savings Potential in the Residential and Commercial Sectors from Hardware Improvements

Sector	Fuel	Savings Achievable (%/year)
Residential	Natural gas	0.5
	Electricity	0.7
Commercial	Natural gas	0.4
	Electricity	0.8

As a check on these figures, we compared the annual achievable savings figures to actual savings achieved by leading utility programs. For example, one of the leading gas efficiency programs in the country is run by XCEL Minnesota. They have achieved approximately 0.5% savings per year in recent years, right in line with our estimate (XCEL Energy 2003). Likewise, among electric utilities, a 1995 analysis by ACEEE found that the leading utilities were achieving energy savings of 0.5 to 1.0% per year, in line with the estimates above (Nadel and Geller 1995). And in 2001, as noted above, California achieved 6% electricity savings, of which one-third (i.e. 2%/year) was in hardware improvements.

We then added the behavioral savings (2.7%) to the hardware savings over five years (annual savings times five) to arrive at overall savings over five years for each fuel and sector.

End-Use Adjustments
Achievable savings varies somewhat by end-use. However, data on achievable savings by end-use is rarely compiled. As a proxy, we looked at estimates on economic savings potential by end-use in comparison to overall sector economic savings potential. Based on these data, we developed multipliers for each end-use, in which a multiplier greater than one means higher than average savings potential and visa versa. Multipliers used are displayed in Table 3.